Marine ecology in the time of 3D modeling:

An evaluation of the efficacy of 3D photogrammetry via Structure-from-Motion in a murky marine environment.

The Monterey Bay National Marine Sanctuary (MBNMS) staff are tasked with managing the resources that fall within the 6094 square miles of ocean that make up California's Monterey Bay National Marine Sanctuary. Their management requirements include protection of the environment and protection of marine resources. Included in those resources are maritime heritage sites. The MBNMS staff commissioned a study that reported 463 vessel losses in or near the MBNMS sanctuary boundaries (Smith and Hunter 2003). NOAA's 2008 Maritime Heritage Action Plan outlined "the need to inventory and assess submerged archaeological resources." Currently very little is known about many of these maritime heritage sites other than their assumed location, based on historical record.

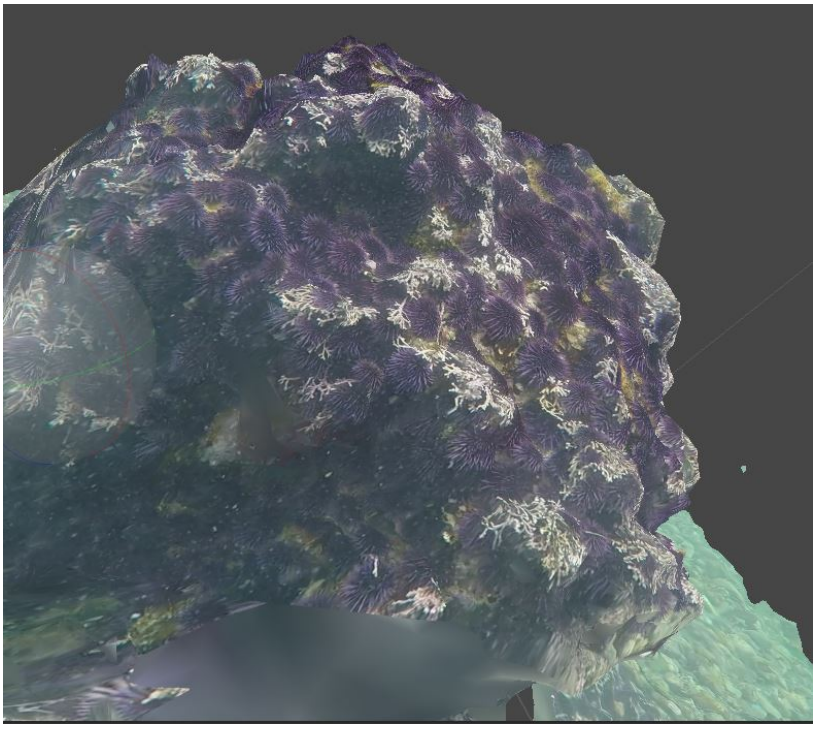

Figure1: Structure-from-Motion photogrammetry can create detailed 3D images of undersea objects, such as this sea urchin covered boulder.

In order to more effectively manage these maritime heritage sites, the MBNMS staff will need baseline data, including location verification, on each site. Additionally, identifying the marine life associated with these maritime heritage sites, and comparing those assemblages to others found on nearby naturally occurring reef structures, will help the MBNMS staff to determine the anthropogenic effects of the maritime heritage sites settling where they did.

One potential method for obtaining this type baseline data is 3D photogrammetry via Structure-from-Motion (SfM) software. 3D photogrammetry has been used terrestrially on a variety of projects, including measuring rates of tree growth in the Pacific Northwest (Gatziolis et al. 2015), and modeling caves in the Ozarks (Jordan 2017). Furthermore, it has shown promise in aquatic studies that sought to measure habitat complexity (Bryson et al. 2017) and model shipwrecks (Beltrame and Costa 2017). An advantage of 3D photogrammetry over traditional LiDAR (Light detection and ranging) techniques is its cost effectiveness. A 2016 study by Casella et al. found that GoPro cameras attached to light weight consumer grade drones were

sufficient to model shallow-water coral reefs in Moorea. Due to the depth of some of the marine heritage sites, it can be dangerous, if not impossible, to monitor effectively via SCUBA (self-contained underwater breathing apparatus).

Although maritime heritage sites can be difficult to access and 3D photogrammetry via SfM remains largely unproven in murky ocean environments, like those found in the MBNMS, I intend to develop and evaluate an effective technique for their monitoring. To that end, I, with the assistance of the Ecosystem Electronics Lab (EEL) at CSUMB, will be attempting to verify the efficacy of remotely operated vehicle (ROV) surveys for gathering video data that can be used as both baseline information and input images for 3D models. I am seeking an undergraduate assistant to join me in exploring this novel approach to further the understanding of our local marine resources.

As an undergraduate student assistant for this project, you will get to assist with:

- Development and evaluation of a novel technique/approach to undersea data visualization

Skills you will learn that I hope will make you more competitive:

- Basic electronics skills
- Small boat experience/handling
- ROV piloting
- Video Data analysis
- 3D Photogrammetry via SfM software

Additional skills you may be introduced to

- Species ID
- Habitat Classification
- Statistical analysis (likely using R)

You will need to be willing and able to:

- Assist in literature review
- Assist in construction, testing, and calibration of equipment necessary to carry out required tasks.
- Spend time on small boats in various weather conditions
- Make a time commitment (3+ hrs/wk)
- Assist in formatting video for photogrammetry software and creation of 3D models

Looking for someone who is

- Punctual
- Attentive to detail
- Attentive to safety guidelines
- Diligent

- Interested in novel technological approaches to answering ecological questions

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